Indicator: Coastal Fish Tissue Contaminants Index (335)

Contaminants in fish tissue not only affect their own health and ability to reproduce, but also affect the many species that feed on them. Contaminants also may make fish unsuitable for human consumption (EPA 2000).

This indicator, derived from an indicator in EPA's Coastal Condition Report (EPA 2004), is based on National Coastal Assessment (NCA) survey data from 653 estuarine sites throughout the United States (except Louisiana, Florida, and Puerto Rico). For the Great Lakes, only non-probabilistic data were available. Fish and shellfish analyzed in the survey included Atlantic croaker, white perch, catfish, flounders, scup, blue crab, lobster shrimp, whiffs, mullet, tomcod, spot, weakfish, halibut, soles, sculpins, sanddabs, basses and sturgeon. At each site, five to ten whole-body fish samples were tested for 90 contaminants, 16 of which have EPA-established risk guidelines for recreational fishers. Contaminant concentrations in fish were compared with established EPA guidelines to assess risks to human health (USEPA 2000). For most fish this is done using whole body concentrations, but for mercury, which concentrates in the edible fillet portion of the fish, a factor of 3.0 was used to correct whole-body concentrations in order to approximate fillet concentrations. The factor, 3.0, represents the median value (range 1.5-5.0) found in the available literature (Windom and Kendall 1979; Mikac et al. 1985; Schmidt and Brumbaugh 1990; Kannen et al. 1998; Canadian Council of Ministers of the Environment 1999).

Each site was rated high, moderate, or low if the fish tissue concentrations fell below, within, or above the risk guideline ranges, respectively. Regions were rated high if (1) more than 20% of the sites were in high condition and fewer than 50% were in moderate or low condition; moderate (3) if 10-20% of sites were in low condition, or fewer than 50% were in high condition; and low (5) if more than 20% of sites were in low condition.

What the Data Show

Fish tissue contamination in the nation's estuaries as a whole were rated moderate (2.7), but six EPA regions were rated - low (Figure 335-1). Only one EPA Region (4) had high fish tissue index scores, and Great Lakes fish were rated moderate. Nationwide, 22% of sites had low fish tissue scores, 15% had moderate scores, and 63% had high scores. More than 1/3 of the sites had low scores in four EPA Regions (1,3, 6, and 9).

Nationwide, PCBs were responsible for poor low condition at the most sites (18%), followed by muscle tissue mercury (17%), total DDT (12%), and total PAHs (5%) (Figure 335-2). Inorganic arsenic, selenium, chlordane, endosulfan, endrin, heptachlor epoxide, hexachlorobenzene, lindane and Mirex were below EPA guidelines for all fish sampled (Figure 335-2).

Indicator Limitations

- The coastal areas of Alaska and Hawaii have been sampled, but not yet assessed.
- Whole-body contaminant concentrations in fish overestimate the risk of consuming only the fillet portion of the fish, with the exception of mercury and cadmium (which are generally underestimated).
- Some fish samples used in the survey were non-market-size juveniles, which are known to have lower contaminant levels than larger, market-sized fish.
- Samples are collected during an index period from July – September, and the indicator is only representative of this time period , but it is not likely that contaminant or TOC levels vary from season to season.

- There is no trend data for this indicator. Fish tissue contaminants are characterized by whole-body concentrations and are compared to EPA risk-based consumption guidelines in the NCCR II. In the NCCR I, fish contaminants were based on fillet concentrations and compared to FDA criteria.

Data Sources

The data source for this indicator is the National Coastal Condition Report II, U.S. Environmental Protection Agency, 2004. http://www.epa.gov/owow/oceans/nccr/2005/downloads.html

References

Canadian Council of Ministers of the Environment (CCME). 1999. Protocol for the Derivation of Canadian Tissue Residue Guidelines for the Protection of Wildlife that Consume Aquatic Biota. Prepared by the Task Force on Water Quality Guidelines.
EPA. 2004. National Coastal Condition Report II, EPA-620/R-03/002. U.S. Environmental Protection Agency, Washington, DC. http://www.epa.gov/owow/oceans/nccr/2005/downloads.html.

Kannan, K., R.G. Smith, R.F. Lee, H.L. Windom, P.T. Heimuller, J.M. Macauley and J.K. Summers, 1998, Distribution of total mercury and methyl mercury in water, sediment and fish from South Flroida estuaries. Arcives of Environmental Contamination and Toixicology 34: 109-118.

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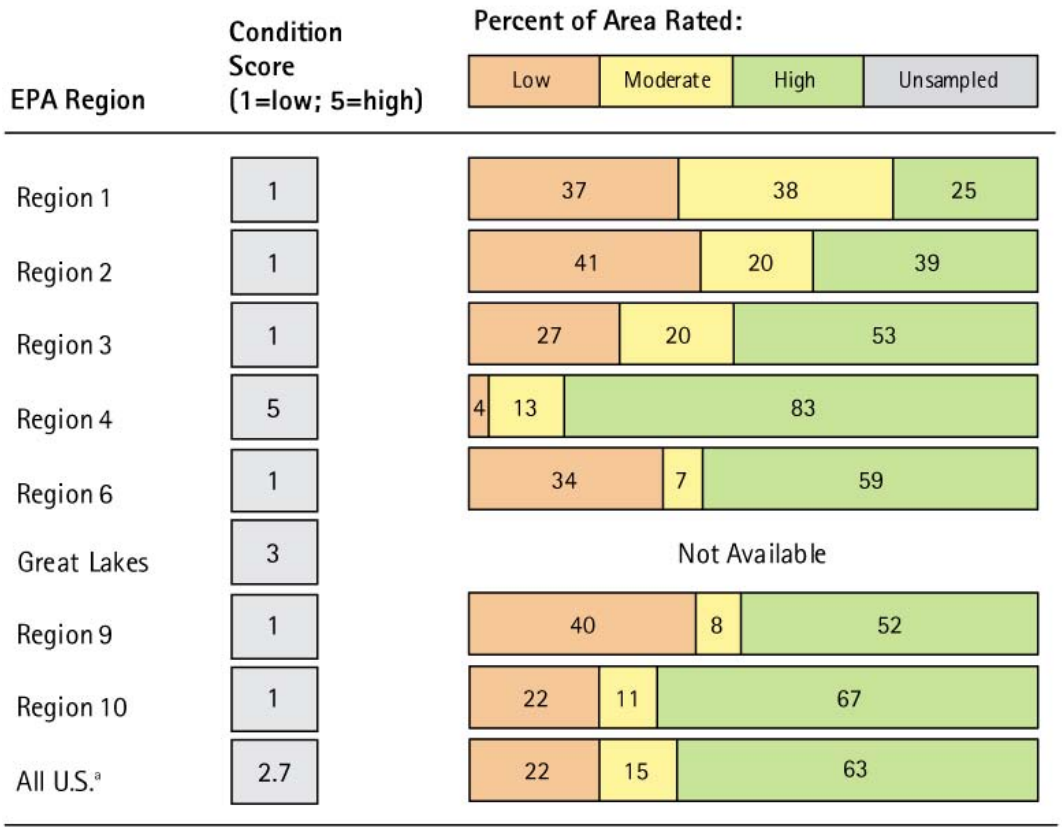
Schmidt, C.J. and W.G. Brumbaugh. 1990. National contaminant biomonitoring program: Concentrations of arsenic, cadmium, copper, lead, mercury selenium and zinc in U.S. freshwater fish 1976-1984. Archives of Environmental Contamination and Toxicology 19: 731-747.

US Environmental Protection Agency. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. EPA-823-B-00-008. Available at http://www.epa.gov/waterscience/library/fish/.

Windom, H.L. and D.R. Kendall. 1979. Accumulation and biotransformation of mercury in coastal and marine biota. Pp. 303-323. In: Nriagu, J.O. (ed.) Biogeochemistry of Mercury in the Environment. Elsevier, Amsterdam.

Graphics

Figure 335-1: Overall Summary of Condition Based on the Fish Tissue Index[b]



Source: National Coastal Condition Report II, US EPA, 2004.

Notes: [a] The national score is based on an aerially weighted mean of the regional scores.

[b] The fish tissue contaminants index is based on a whole-body analysis of the fish.

Figure 335-2. Contaminant Concentrations in Fish Tissue (Percent of U.S. Sites in Each Guideline Category)[a]

Contaminant	Guideline	Percent of Sites in Guideline Category: Exceeds	Within	Below
Arsenic (inorganic)[b]	3.5 - 7.0	0	0	100
Cadmium	0.35 - 0.7	<1	<1	99
Mercury (total body)	0.12 – 0.23	<1	<1	99
Mercury (muscle tissue)	0.12 – 0.23	18	24	58
Selenium	5.9 – 12.0	0	0	100
Chlordane	0.59 – 1.2	0	0	100
DDT	.059 – 0.12	8	4	88
Dieldrin	.059 – 0.12	<1	0	99
Endosulfan	7.0 – 14.0	0	0	100
Endrin	0.35 – 0.70	0	0	100
Heptachlor Epoxide	.015 - .031	0	0	100
Hexaclorobenzene	0.94 – 1.9	0	0	100
Lindane	0.35 – 0.70	0	0	100
Mirex	0.23 – 0.47	0	0	100
Toxaphene	0.29 - 0.59	<1	0	99
PAH (Benzo(a)pyrene)	.0016-.0032	3	2	95
Total PCBs	.023 - .047	19	11	70

Risk Guidelines for Recreational Fishers for Four 8-Ounce Meals Per Month for Non-Cancer Risk (except Total PAHs which is cancer risk) (concentration in ppm) and percentage of coastal sites in US sampled by NCA within these guideline categories Source: National Coastal Condition Report II, U.S. EPA, 2004.

[a]For most contaminants, the comparison is based on whole fish body concentrations, but for mercury, which concentrates in the edible fillet portion of the fish, a factor of 3.0 was used to correct whole-body concentrations in order to approximate fillet concentrations. The factor, 3.0, represents the median value (range 1.5-5.0) found in the available literature (Windom and Kendall 1979; Mikac et al. 1985; Schmidt and Brumbaugh 1990; Kannen et al. 1998; Canadian Council of Ministers of the Environment 1999).

[b]Inorganic arsenic estimated as 2% of total arsenic.

R.O.E. Indicator QA/QC

Data Set Name: COASTAL FISH TISSUE CONTAMINANTS INDEX
Indicator Number: 285 (89143)
Data Set Source: EPA/EMAP/NCA
Data Collection Date: 1999-2000
Data Collection Frequency: annually
Data Set Description: This index reflects the levels of chemical contaminants in target fish/shellfish species using concentrations as an indicator.
Primary ROE Question: What are the trends in the contamination/quality/safety of consumablefish and shellfish contamination?

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Methods described for this survey represent a combination of standard, scientifically accepted sampling and analytical methodologies. They are described in ; US EPA 2001. National Coastal Assessment: Field Operations Manual. U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA 620/R-01/003. pp72. U.S. EPA. 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual-Estuaries, Volume 1: Biological and Physical Analyses. U.S. Environmental Protection Agency, Office of Research and Development , Narragansett, RI. EPA/620/R-95/008. http://www.epa.gov/emap/html/pubs/docs/groupdocs/estuary/index.html

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

There is an entire portion of the EMAP website dedicated to principles and implementation of the NCA monitoring design and analysis. http://www.epa.gov/nheerl/arm/index.htm Diaz-Ramos, S., Stevens, D.L., Jr and Olsen, A.R. (1996) EMAP Statistical Methods Manual. Rep. EPA/620/R-96/002, U.S. Environmental Protection Agency, Office of Research and Development, NHEERL-WED, Corvallis, Oregon. Olsen, A.R., Stevens, D.L., Jr. and White, D. (1998) Application of global grids in environmental sampling. Computing Science and Statistics, 30, 279-84. Stevens, D.L., Jr. (1997) Variable density grid-based sampling designs for continuous spatial populations. Environmetrics, 8, 167-95. Stevens, D.L., Jr. and Olsen, A.R. (1999) Spatially restricted surveys over time for aquatic resources. Journal of Agricultural, Biological, and Environmental Statistics, 4, 415-28. Stevens, D.L., Jr. and Urquhart, N.S. (1999) Response designs and support regions in sampling continuous domains. Environmetrics, 11, 13-41. Stevens, D. L., Jr. and Olsen, A. R. Variance Estimation for Spatially Balanced Samples of Environmental Resources. Environmetrics 14:593-610. Stevens, D. L., Jr. and A. R. Olsen (2004). "Spatially-balanced sampling of natural resources." Journal of American Statistical Association 99(465): 262-278.

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Contaminant residues are examined in the fillets, whole bodies, or specific organs of target finfish and shell fish and compared with risk-based EPA fish contaminant guidance values.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

Sampling for the indicator presents available information on a national scale for the conterminous 48 states and Puerto Rico. There are 50 sites sampled each year for each of the states or territory. Data collection began in 1999 and is ongoing in 2004.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

Sensitive populations or ecosystems are represented to a limited extent. The monitoring design at the scale presented is to characterize condition on a regional scale, not specific areas.

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

Threshold values for contaminant levels in fish and shellfish tissue are based on the consumption of four 8 ounce meals per month and assessed for noncancer and cancer health endpoints. No guidance criteria exist to assess the ecological risk of whole body contaminants for fish, but the EPA advisory guidance can be used for estimating advisory determinations. U.S. EPA. 2000c. Guidance for assessing chemical contaminant data for use in fish advisories, volume 2: Risk Assessment and Fish Consumption Limits. EPA-823-B-00-008. Office of Water, Washington, DC.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

U.S. EPA. 1995. Environmental Monitoring and Assessment Program (EMAP): Laboratory Methods Manual-Estuaries, Volume 1: Biological and Physical Analyses. U.S. Environmental Protection Agency, Office of Research and Development , Narragansett, RI. EPA/620/R-95/008. U.S. EPA. 2001. Environmental Monitoring and Assessment Program (EMAP): National Coastal Assessment Quality Assurance Project Plan. . U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002. U.S. EPA. 2001. National Coastal Assessment Field Operations Manual. U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/003.
http://www.epa.gov/emap/html/pubs/docs/groupdocs/estuary/index.html

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

http://www.epa.gov/emap/nca/html/data/index.html Stephen Hale, U.S. EPA, Atlantic Ecology Division, (401) 782-3048

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

Yes, Using the documentation provided for the design can be reproduced by a competent statistician. All of the field sampling and analytical methods are also well documented.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

U.S. EPA. 2001. Environmental Monitoring and Assessment Program (EMAP): National Coastal Assessment Quality Assurance Project Plan. . U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002 Hale, S., J. Rosen, D. Scott, J. Paul, and M. Hughes. 1999. EMAP Information Management Plan: 1998-2001. U.S. Environmental Protection Agency, Office of Research and Development , Narragansett, RI. http://www.epa.gov/emap/html/pubs/docs/groupdocs/estuary/index.html

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical survey inference, no generalization is possible)?

There is an entire portion of the EMAP website dedicated to principles and implementation of the NCA monitoring design and analysis. http://www.epa.gov/nheerl/arm/index.htm Diaz-Ramos, S., Stevens, D.L., Jr and Olsen, A.R. (1996). See T1Q2.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Yes, measurements of uncertainty are provided with each indicator. http://www.epa.gov/nheerl/arm/index.htm

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

Inconsistency in application of the design, sample collection, or sample analysis. These are controlled through standardization of methodologies, publication of operational manuals, and training of personnel involved. It is monitored through quality assurance requirements and audits.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

The only data gaps would be from missing or lost samples. In this event The analyses is performed without those sites. Any error associated with the index may only increase slightly, but would be controlled by the number of sites and the survey design.